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First records of parasitic copepods (Crustacea, Siphonostomatoida) from marine fishes in Korea

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Abstract. The knowledge of the biodiversity of parasitic copepods in South Korea is increasing. Interestingly we report here, some parasitic copepods considered as the first record of findings from Korea. Nine species of parasitic copepods (Siphonostomatoida) including six genera of three different families [Caligidae (7), Lernaeopodidae (1), Lernanthropidae (1)] were recovered from eight species of wild fishes in Korea: 1) *Caligus hoplognathi* Yamaguti & Yamasu, 1959 (♀, ♂) from the body surface of barred knifejaw *Oplegnathus fasciatus* (Temminck & Schlegel); 2) *Caligus lagocephali* Pillai, 1961 (♀) from the gills of panther puffer *Takifugu pardalis* (Temminck & Schlegel); 3) *Euryphorus brachypterus* (Gerstaecker, 1853) (♀, ♂) from the opercular cavity of Atlantic bluefin tuna *Thunnus thynnus* (Linnaeus); 4) *Euryphorus nordmanni* Milne Edwards, 1840 (♀, ♂) from the opercular cavity of common dolphin fish *Coryphaena hippurus* Linnaeus; 5) *Gloiopotes huttoni* (Thomson) (♀, ♂) from the body surface of black marlin *Istiompax indica* (Cuvier); 6) *Lepeophtheirus hapalogenyos* Yamaguti & Yamasu, 1959 (♀) from the gill filaments of *O. fasciatus*; 7) *Lepeophtheirus sekii* Yamaguti, 1936 (♀, ♂) from the body surface of red seabream *Pagrus major* (Temminck & Schlegel); 8) *Brachiella thynni* Cuvier, 1830 (♀) from the body surface of longfin tuna or albacore *Thunnus alalunga* (Bonnaterre); 9) *Lernanthropinus sphyraenae* (Yamaguti & Yamasu, 1959) (♀) from the gill filaments of moon fish *Mene maculata* (Bloch & Schneider). Since the female was already reported in Korea, it is a new record for the male of *C. hoplognathi*. A checklist for the parasitic copepods of the family Caligidae, Lernaeopodidae and Lernanthropidae of Korea is provided.

INTRODUCTION

The impact of humans on the world's oceans and global climate change can cause marine organisms to become vanish or extinct (Arvedlund, 2009). It also has direct effects on the biogeography and ecology of marine fish populations. Copepods are a common component of the ectoparasite assemblages of fishes, from most environments and ecosystems (Boxshall & Halsey, 2004). However, only few fish species have been reported as hosts for parasitic copepods. This is possibly due to a decline in the number of parasitic copepodologists worldwide, especially in Asia (Ho, 2001). Parasitic copepods are common on cultured and wild marine fishes (Johnson *et al.*, 2004; Venmathi Maran *et al.*, 2009; 2012) and freshwater ones as well (Piasecki *et al.*, 2004). However,

some copepods like caligids, lernaeopodids, hatschekids, and lernanthropids are dominant among parasitic copepods of fishes (Dojiri & Ho, 2013). Since it is necessary to improve our knowledge on the biodiversity of parasitic copepods in Korea, here we report the discovery of several known species of parasitic copepods (Siphonostomatoida), which are new records for the Korean fauna.

The dominant parasitic copepods in our collection is belonging to the genus *Caligus* Müller, 1785 (Siphonostomatoida), the most speciose genus within the family Caligidae, well known as sea lice. It currently includes more than 250 species parasitizing marine fishes around the world (Dojiri & Ho, 2013). Sea lice have been considered as a serious pest of finfish in commercial aquaculture facilities around the world (Johnson *et al.*, 2004). In Korea, the number of caligid species increased from 25 in 2008 (Kim, 2008) to 40 in 2013 (Moon & Kim, 2012; Venmathi Maran *et al.*, 2012). In other families of parasitic copepods, representatives of Bomolochidae and Taeniacanthidae are currently dominating in Korea (Kim & Moon, 2013). In this study, we report parasitic copepods of three families of Caligidae, Lernaeopodidae and Lernanthropidae, in which nine species are new to the Korean fauna. In addition, a checklist of siphonostomatoids for all three families is provided from Korea.

MATERIALS AND METHODS

Parasitic copepods were obtained from the following sources (Table 1) collected from several fishes off several parts of Korea. The copepods were carefully removed using fine forceps from the body surface, the eye and the gill filaments of several fish hosts under a dissecting microscope and preserved in 70% ethanol. Preserved copepods were cleared in a drop of 85% lactic acid or lactophenol prior to examination using an Olympus BX51 phase contrast microscope. Selected specimens were measured intact using an ocular micrometer and/or dissected and examined according to the wooden slide procedure of Humes & Gooding (1964). All parasitic copepods were identified according to Cressey (1967), Kabata (1979), Kim (1998), Ho *et al.* (2008) and Dojiri & Ho (2013). The common and scientific names of host fishes were according to Froese & Pauly (2014). Microphotographs of some of the specimens from all three families are provided. Voucher specimens are deposited at the National Institute of Biological Resources (NIBR), Incheon, Korea.

RESULTS

Nine species of siphonostomatoid copepods from six genera of three families were identified. It comprises two species of each *Caligus*, *Lepeophtheirus* and *Euryphorus* and one species of each *Gloiopotes* (Caligidae), *Brachiella* (Lernaeopodidae) and *Lernanthropinus* (Lernanthropidae) (Table 1).

Order Siphonostomatoida Burmeister, 1835

Family Caligidae Burmeister, 1835

***Caligus hoplognathi* Yamaguti & Yamasu, 1959**

Material examined. 1♀ and 1♂ (NIBRIV0000306297) from gills of barred knifejaw *Oplegnathus fasciatus* (Temminck & Schlegel, 1844) (Perciformes: Oplegnathidae), Tongyeong Fish Market, Gyeongsangnamdo, South Korea, August 20, 2012.

Remarks. *Caligus hoplognathi* was first reported from the Inland Sea, Japan based on 9 gravid females captured from the same host *O. fasciatus* by Yamaguti & Yamasu (1959). After that, one female was collected from the same host in the East Sea (Kim, 1998). But, so far the male was not recorded in both Japan and Korea (Nagasawa *et al.*, 2010), hence here the reported male is the first finding. We collected both sexes from gills of *O. fasciatus* and it is only the third record of occurrence in the world.

Distribution. Korea (present study) and Japan.

Table 1. Parasitic copepods of nine species infecting marine fishes in Korea

Parasitic copepods	Host	Site	Locality
Caligus hoplognathi Yamaguti & Yamasu, 1959	*Oplegnathus fasciatus* (Perciformes: Oplegnathidae)	body surface	Tongyeong
Caligus lagocephali Pillai, 1961	*Takifugu pardalis* (Tetraodontiformes: Tetraodontidae)	gills	Yeosu
Euryphorus brachypterus (Gerstaecker, 1853)	*Thunnus thynnus* (Perciformes: Scombridae)	opercular cavity	Busan
Euryphorus nordmanni H. Milne Edwards, 1840	*Coryphaena hippurus* (Perciformes: Coryphaenidae)	opercular cavity	Seoul
Gloiopotes huttoni (G.M. Thomson, 1890)	*Istiompax indica* (Perciformes: Istiophoridae)	body surface	East Sea
Lepeophtheirus hapalogenyos Yamaguti & Yamasu, 1959	*Oplegnathus fasciatus*	gills	Tongyeong
Lepeophtheirus sekii Yamaguti, 1936	*Pagrus major* (Perciformes: Sparidae)	body surface	Yeosu
Brachiella thynni Cuvier, 1830	*Thunnus alalunga* (Perciformes: Scombridae)	body surface	Yeosu
Lernanthropinus sphyraenae (Yamaguti & Yamasu, 1959)	*Mene maculata* (Perciformes: Menidae)	gills	Seoul

***Caligus lagocephali* Pillai, 1961**

Material examined. 1 ♀ (NIBRIV0000306298) from gills of panther puffer *Takifugu pardalis* (Temminck & Schlegel, 1850) (Tetraodontiformes: Tetraodontidae), Yeosu Fish Market, Jeollanamdo, South Korea, August 29, 2013.

Remarks. *Caligus fugu* Yamaguti & Yamasu (1959) (17 gravid females and 5 mature males) was identified based on its striking feature of the maxilliped. It was collected from the mouth cavity (palate) of four toxic puffer fishes, *Takifugu alboplumbeus* (Richardson, 1845), *T. niphobles* (Jordan & Snyder, 1901), *T. rubripes* (Temminck & Schlegel, 1850) and *T. pardalis* (Temminck & Schlegel, 1850) captured from the Inland Sea, Japan on December 3, 1958 (see Yamaguti & Yamasu, 1959). But, Pillai (1961) unknowingly erected the already reported *C. fugu* as a new species *Caligus lagocephali* Pillai, 1961 for his specimen collected from the toxic fish smooth blaasop *Lagocephalus inermis* (Temminck & Schlegel, 1850) from Kerala, India (Pillai, 1961; 1985). Both species were synonymised later as *C. fugu* (see Boxshall & El-Rashidy, 2009).

Recently, *C. lagocephali* was reported from two immigrant fish species *Lagocephalus suezensis* Clark & Gohar, 1953 and *L. spadiceus* (Richardson, 1845) from the Red Sea, Turkey (Özak *et al.*, 2012). Since Dojiri and Ho (2013) formally recognized the genus *Pseudocaligus* as a junior synonym of *Caligus*, the toxic caligid *Pseudocaligus fugu* Yamaguti, 1936 is relegated to *Caligus fugu* (Yamaguti, 1936). In relation to that, the already reported *C. fugu* becomes a junior homonym of *C. lagocephali* (see Özak *et al.*, 2013). Although several findings are available from the neighboring country Japan, this is the first report in Korea.

Distribution. The Seto Inland Sea of Japan, Kerala, West Coast of India, Mediterranean Sea and Yeosu, southern part of Korean waters (present study).

***Euryphorus brachypterus* (Gerstaecker, 1853)**

Material examined. 5♀♀ and 2♂♂ (NIBRIV0000306299) from the opercular cavity of Atlantic bluefin tuna *Thunnus thynnus* (Linnaeus, 1758) (Perciformes: Scombridae), Busan Fish Market, South Korea, November 25, 2013.

Remarks. *Euryphorus* Milne Edwards H., 1840 is distinguished from other caligid genera, except *Avitocaligus* Boxshall & Justine, 2005 by a distinctly biramous fourth leg and this genus is similar to *Alebion* Krøyer, 1863 (Boxshall & Halsey, 2004; Dojiri & Ho, 2013). There are only two species of the genus *Euryphorus*, namely *E. brachypterus* and *E. nordmanni*. Both are reported from several parts of the world, since it is a common copepod parasitic mostly on large scombrids (Dojiri & Ho, 2013). Both species are misidentified and reported as various species or genera around the world (see: Dojiri & Ho, 2013). *Euryphorus brachypterus* was reported from various hosts of offshore pelagic fishes. However, this is the first report from Korea.

Distribution. North and South Atlantic, Indian and North and South Pacific Oceans, Korea (present study).

***Euryphorus nordmanni* H. Milne Edwards, 1840**

Material examined. 4♀♀ and 2♂♂ (NIBRIV0000306300) from the opercular cavity of common dolphin fish *Coryphaena hippurus* Linnaeus, 1758 (Perciformes: Coryphaenidae), Seoul Fish Market, South Korea, May 8, 2013.

Remarks. Many features between *E. nordmanni* and *E. brachypterus* are similar but can be well differentiated in the feature of the genital complex and aliform flaps of the first abdominal somite (Lewis, 1967; Dojiri & Ho, 2013). The common host of *E. nordmanni* is common dolphinfish, but reported from several other fish hosts from different parts of the world. As like other species *E. brachypterus*, it was also reported in so many names (see Table VIII, Dojiri & Ho, 2013). This is the first report from Korea.

Distribution. North and South Atlantic, Indian and North and South Pacific Oceans, Korea (present study).

***Gloiopotes huttoni* (G.M. Thomson, 1890)**

(Figures 1, 2)

Material examined. 5♀♀ and 1♂ (NIBRIV0000306301) from body surface of black marlin *Istiompax indica* (Cuvier, 1832) (Perciformes: Istiophoridae) (Set Net), Cheong Se Chi, East Sea, South Korea, June 24, 2014.

Remarks. We collected both sexes of *Gloiopotes huttoni* from the billfish *I. indica* (Figure 1A, B) captured using the Set net off East Sea, Korea. According to Cressey (1967), a key character for the diagnosis of *G. huttoni* is its genital complex; it is longer than wide and the tip of 5th leg is not extending to the end of the abdomen. This feature does fit well with our specimens. There are five species of *Gloiopotes*: *G. americanus* Cressey, 1967, *G. huttoni*, *G. hygomianus* Steenstrup & Lütken, 1861, *G. ornatus* Wilson C.B., 1905 and *G. watsoni* Kirtisinghe, 1934 (Boxshall & Halsey, 2004). Cressey (1967) described the host specificity of all five species. Our specimen *G. huttoni* (Figure 2) is specific to billfishes and sword fishes of the Indo-Pacific Ocean. It was reported from Japan (Yamaguti, 1963; Ho & Nagasawa, 2001) from several billfishes and here it was also collected from billfish.

Distrbution. Indo-Pacific Ocean, Korea (present study), Japan.

***Lepeophtheirus hapalogenyos* Yamaguti & Yamasu, 1959**

Material examined. 1♀(NIBRIV0000306302) from gills of *Oplegnathus fasciatus* from Tongyeong Fish Market, Gyeonsangnamdo, South Korea, August 20, 2012.

Remarks. *Lepeophtheirus hapalogenyos* was first reported based on 4 gravid females and 4 mature males captured from *Hapalogenyos mucronatus* (Eydoux & Souleyet, 1850) at the aquarium of Tokyo University, Japan by Yamaguti & Yamasu (1959). After that, it was not reported elsewhere (Nagasawa *et al.*, 2010). Hence, the reported female is the first

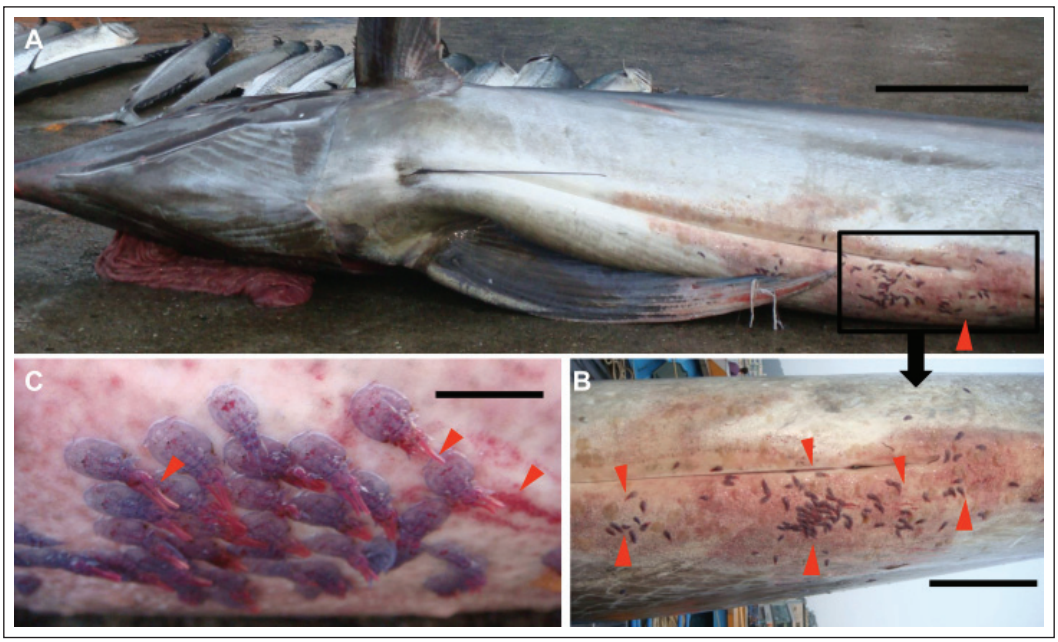

Figure 1. A) Black marlin *Istiompax indica* (Perciformes: Istiophoridae) captured using Set Net, Cheong Se Chi, East Sea, South Korea found with severe infection of *Gloiopotes huttoni* (Caligidae); B) Enlarged part on the ventral side, near anal region showing severe infection of caligid (arrow-marked); C) Number of *G. huttoni* (egg sacs hanging – arrow) and lesions (right arrow) on the infected part due to its feeding activity using its powerful feeding parts. Scale bars: A. 5 cm; B. 3 cm; C. 1.5 cm

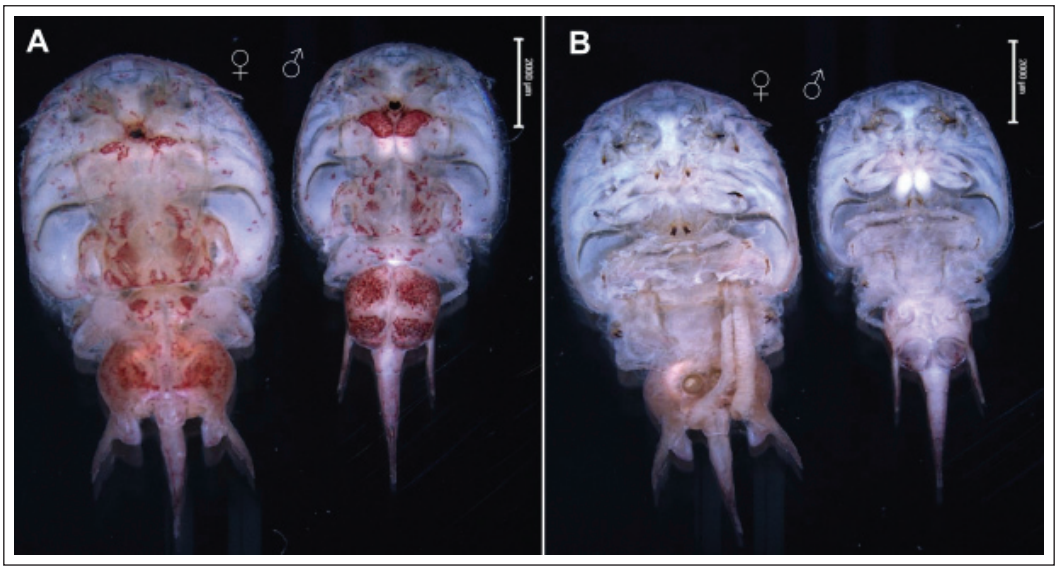

Figure 2. A) *Gloiopotes huttoni*, dorsal view of female and male; B) *Gloiopotes huttoni*, ventral view of female showing egg sacs and spermatophore and male.

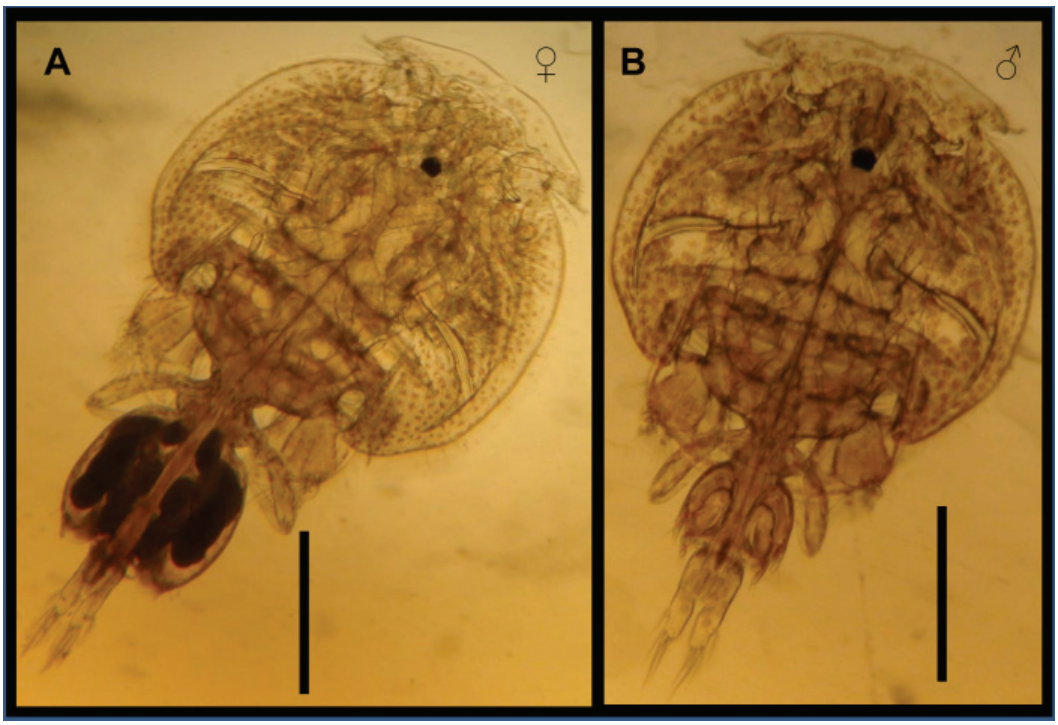

Figure 3. A) *Lepeophtheirus sekii* (Caligidae) dorsal side of female and B) male. Scale bars: A, B. 1 cm.

finding from Korea. It closely resembles *L. sekii* Yamaguti, 1936, but differs in the longer genital complex, which is shorter and wider in *L. sekii*.

Distribution. Korea (present study), Japan.

***Lepeophtheirus sekii* Yamaguti, 1936**
(Figure 3)

Material examined. 1♀ and 1♂ (NIBRIV0000306303), from body surface of red seabream *Pagrus major* (Temminck & Schlegel, 1843) (Perciformes: Sparidae), Yeosu, Jeollanamdo, South Korea, September 14, 2012. Additional material: 1♀ (NIBRIV0000306304) from the body surface of *P. major*, Akitsu and Osaki Kamijima Island, Takehara, Hiroshima Prefecture, Japan, July 20, 2010.

Remarks. *Lepeophtheirus sekii* was first reported based on 7 females and 1 male collected from Otya, Hiroshima Prefecture in 1935 by Yamaguti (1936) but no host was listed (Nagasawa, 2011). However, later the genus level host (*Pagrosomus* sp.) was reported by Yamaguti (1963). Meanwhile, in 2010, *L. sekii* was identified from the body surface of wild *Pagrus major* collected from Akitsu and Osaki Kamijima Island, western Japan. *Lepeophtheirus sekii* is host specific to sparid fishes, since it was already reported from various sparids such as the yellowfin bream *Acanthopagrus australis* (Owen, 1853) and the silver seabream *Pagrus auratus* (Forster, 1801) (Sparidae) (Roubal *et al.*, 1983; Byrnes, 1987; Byrnes & Rhode, 1992). It was also reported from *P. auratus* and *A. australis* off Okakari Point and Kawau Bay, New Zealand (Roubal *et al.*, 1983; Sharples & Evans, 1995).

Recently, *L. sekii* was collected from wild *P. major* from both Korea (present study) and Japan (Kaji *et al.*, 2012), interestingly, cultured *P. major* was never reported carrying *L. sekii*. Likewise, another sea lice *Caligus sclerotinosus* Roubal, Armitage & Rhode, 1983 was reported from cultured *P. major* in Korea and Japan, but not found from wild (Venmathi Maran *et al.*, 2012).

Distribution. Australia, New Zealand, Japan, Korea (present study)

Family Lernaeopodidae H. Milne Edwards, 1840

***Brachiella thynni* Cuvier, 1830** (Figure 4)

Material examined. 3♀♀(NIBRIV0000306305) from body surface of longfin tuna or albacore *Thunnus alalunga* (Bonnaterre, 1788) (Perciformes: Scombridae), Yeosu Fish Market, Jeollanamdo, South Korea, September 8, 2012.

Remarks. Twelve valid species of *Brachiella* Cuvier, 1830 have so far been recognized (WoRMS Editorial Board, 2014). *Brachiella thynni* was first reported from *T. alalunga* in 1830, after that this species had been reported from several countries off several pelagic fish hosts including the wahoo *Acanthocybium solandri* (Cuvier, 1832), bigeye tuna *Thunnus obesus* (Lowe, 1839) and yellowfin tuna *Thunnus albacores* (Bonnaterre, 1788) (Lewis, 1967; Shiino, 1956). It is a first report to Korea found from albacore host.

Distribution. Indo-Pacific Ocean, Korea (present study), Japan.

Family Lernanthropidae Kabata, 1979

***Lernanthropinus sphyraenae* (Yamaguti & Yamasu, 1959)** (Figure 5)

Material examined. 3♀♀(NIBRIV0000306306) from gill filaments of moon fish *Mene maculata* (Bloch & Schneider, 1801) (Perciformes: Menidae) from Seoul Fish Market, Gyeongido, South Korea, November 14, 2013.

Remarks. Copepods of the family Lernanthropidae are highly modified parasites found exclusively on the gill filaments of host fishes. In female, leg 3 is modified as large, folded lamellae for clinging to the gill filaments (Ho *et al.*, 2011). The genus *Lernanthropinus* (Lernanthropidae) was adopted by Do in Ho & Do, 1985 based on two lateral plates (Ho & Do, 1985). Following this feature, eight

Figure 4. A) *Brachiella thynni* (Lernaeopodidae) dorsal view of female and B) lateral view of female. Scale bars: A, B. 0.5 cm.

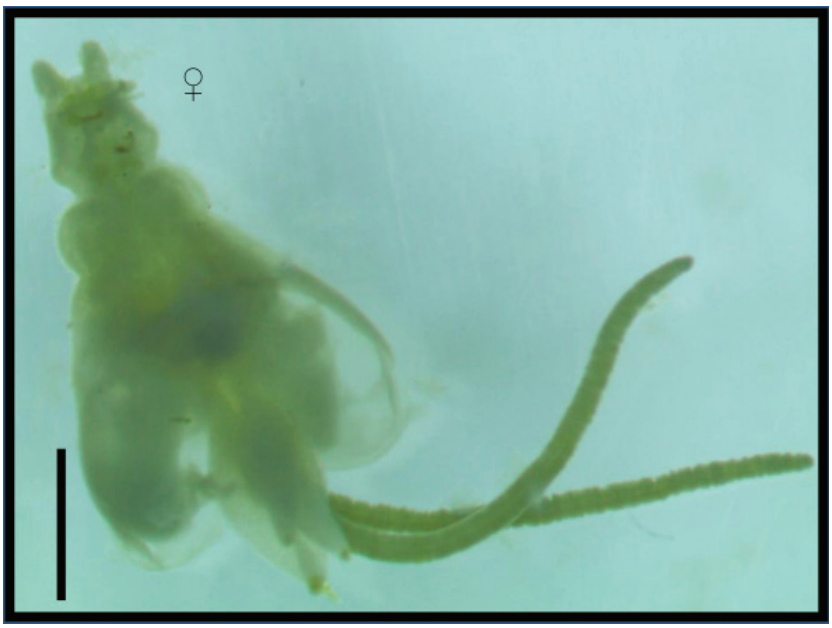

Figure 5. A) *Lernanthropinus sphyraenae* (Lernanthropidae) dorsal view of female. Scale bars: A. 1 cm.

species of *Lernanthropus* de Blainville, 1822 were transferred to *Lernanthropinus* (see Ho & Do, 1985; Ho *et al.*, 2008, 2011) and we report here one of the species as *Lernanthropinus sphyraenae*. Recently, Venmathi Maran *et al.* (2014a) relegated two species *L. gibbosus* (Pillai, 1964) and *L. sauridae* Do, in Ho and Do, 1985 collected from the greater lizard fish *Saurida tumbil* (Bloch, 1795) of India and Japan to *L. temminckii* (von Nordmann, 1864) (Cressey & Cressey, 1979; Pillai, 1985; Ho & Do, 1985) based on its features, which reduced the number of valid species of *Lernanthropinus* to six. *L. sphyraenae* is host specific to the moon fish *Mene maculata* (Ho & Sey, 1996; Ho *et al.*, 2008).

Distribution. Korea (present study), Japan, Kuwait, and Taiwan.

DISCUSSION

In Korea, recently ten species of parasitic copepods (Cyclopoida) belonging to three different families of Bomolochidae, Phylichthyidae and Taeniacanthidae were reported (Kim & Moon, 2013). Likewise, many new species, life cycles and ecology of parasitic copepods are continuously reported in Korea (Moon & Kim, 2012; Venmathi Maran *et al.*, 2012, 2013, 2014b). Our report includes nine species of parasitic copepods of three different families representing a new record to the Korean fauna.

In this study the dominant copepod family was Caligidae (7 species). In 2008 there were only three genera of Caligidae recorded in Korea, including 14 species of *Caligus*, 10 *Lepeophtheirus*, and 1 *Pseudocaligus* (Kim, 2008). In addition to that, 1 more species (Choe & Kim, 2010), 2 including pelagic (Venmathi Maran & Ohtsuka, 2008) and parasitic (Venmathi Maran *et al.*, 2012) and 13 more species of caligids including the first record of three genera (Moon & Kim, 2012) were reported from Korean waters (Table 2). Here we add 7 caligid species of four genera such as *Caligus*, *Lepeophtheirus*, *Euryphorus* and *Gloiopotes* as new records and the latter two genera represent first reports for Korea. In total, there are 47 species of seven genera of Caligidae recorded in Korea (Table 2). *Gloiopotes huttoni* infected the fish host black marlin (Figure 1A). Near the anal region in the ventral part of the host

Table 2. Checklist of parasitic copepods of the families Caligidae, Lernaeopodidae and Lernanthropidae in Korea

Family Caligidae Burmeister, 1835

Genus *Anuretes* Heller, 1865
- *Anuretes quadrilaterus* Shiino, 1954

Genus *Caligus* Müller, 1785
- *Caligus aesopus* Wilson, 1921
- *Caligus elongatus* Nordmann, 1832
- *Caligus equulae* Ho & Lin, 2003
- *Caligus fistulariae* Yamaguti, 1936
- *Caligus fugu* (Yamaguti, 1936) (= *Pseudocaligus fugu*)
- *Caligus hoplognathi* Yamaguti & Yamasu, 1959
- *Caligus lagocephali* Pillai, 1961
- *Caligus lalandei* Barnard, 1948
- *Caligus laticaudus* Shiino, 1960
- *Caligus latigenitalis* Shiino, 1954
- *Caligus longipes* Moon & Kim, 2012 (= *Pseudocaligus longipes*)
- *Caligus macarovi* Gusev, 1951
- *Caligus orientalis* Gusev, 1951
- *Caligus oviceps* Shiino, 1952
- *Caligus parvilatus* Kim, 1995
- *Caligus pelamydis* Krøyer, 1863
- *Caligus punctatus* Shiino, 1955
- *Caligus quadratus* Shiino, 1954
- *Caligus rotundigenitalis* Yü, 1933
- *Caligus sclerotinosus* Roubal, Armitage & Rhode, 1983
- *Caligus seriolae* Yamaguti, 1936
- *Caligus spinosus* Yamaguti, 1939
- *Caligus tanago* Yamaguti, 1939
- *Caligus triangularis* Shiino, 1954
- *Caligus undulatus* Shen & Li, 1959

Genus *Euryphorus* Milne-Edwards, 1840
- *Euryphorus brachypterus (Gerstaecker, 1853)*
- *Euryphorus nordmanni H. Milne Edwards, 1840*

Genus *Gloiopotes* Steenstrup and Lütken, 1861
- *Gloiopotes huttoni* (G.M. Thomson, 1890)

Genus *Lepeophtheirus* von Nordmann, 1832
- *Lepeophtheirus atypicus* Lin, Ho & Chen, 1996
- *Lepeophtheirus bychowskyi* Gusev, 1951
- *Lepeophtheirus elegans* Gusev, 1951
- *Lepeophtheirus goniistii* Yamaguti, 1936
- *Lepeophtheirus gusevi* Moon & Kim, 2012
- *Lepeophtheirus hapalogenyos* Yamaguti & Yamasu, 1959
- *Lepeophtheirus hexagrammi* Gusev, 1951
- *Lepeophtheirus hospitalis* Fraser, 1920
- *Lepeophtheirus paralichthydis* Yamaguti & Yamasu, 1959
- *Lepeophtheirus parviventris* Wilson, 1905
- *Lepeophtheirus parvulus* Shiino, 1952
- *Lepeophtheirus salmonis* Krøyer, 1863
- *Lepeophtheirus sekii* Yamaguti, 1936
- *Lepeophtheirus semicossyphi* Yamaguti, 1936
- *Lepeophtheirus tamradus* Moon & Kim, 2012
- *Lepeophtheirus tuberculatus* Kim, 1936

Genus *Metacaligus* Thomsen, 1949
- *Metacaligus uruguayensis* (Thomsen, 1949)

Genus *Pseudanuretes* Yamaguti, 1936
- *Pseudanuretes chaetodontis* Yamaguti, 1936

Family Lernaeopodidae Milne Edwards, 1840
Genus *Alella* Leigh-Sharpe, 1925
Alella ditrematis (Yamaguti, 1939)
Alella macrotrachelus (Brian, 1906)
Genus *Brachiella* Cuvier, 1830
Brachiella thynni Cuvier, 1830
Genus *Clavella* Oken, 1815
Clavella adunca (Strøm, 1762)
Clavella irina Wilson, 1915
Clavella parva Wilson, 1912
Clavella perfida Wilson, 1915
Genus *Clavellisa* Wilson, 1915
Clavellisa dorosomatis Yamaguti, 1939
Genus *Clavellotis* Castro-Romero & Baeza-Kurok, 1984
Clavellotis dilatata (Krøyer, 1863) (= *Clavellotis sargi*)
Genus *Parabrachiella* Wilson, 1915 (= *Neobrachiella*)
Parabrachiella hugu (Yamaguti, 1939) (= *Neobrachiella hugu*)
Parabrachiella bera (Yamaguti, 1939) (= *Neobrachiella incurva*)

Family Lernanthropidae Kabata, 1979
Genus *Lernanthropinus* Do in Ho & Do, 1985
Lernanthropinus sphyraenae (Yamaguti & Yamasu, 1959)
Genus *Lernanthropsis* Do in Ho & Do, 1985
Lernanthropsis mugilii (Shishido, 1898)
Genus *Lernanthropus* de Blainville, 1822
Lernanthropus tylosuri Richiardi, 1880

(Figure 1B), many *G. huttoni* was found. All caligids were reddish in color and we could see the lesions on the body of the host fish (Figure 1B, C) caused by constant feeding and irritation by the parasites (Dojiri & Ho, 2013). Seven genera out of 31 for the family Caligidae were reported from Korea until now.

The other two genera (*Brachiella* and *Lernanthropinus*) which are new to Korea belonging to the family Lernaeopodidae and Lernanthropidae. The Lernaeopodidae is the second largest family in the fish-parasitizing order Siphonostomatoida. In Korea, six genera including 10 species of Lernaeopodidae have so far been reported (Kim, 1998; Moon, 2014). In the present study, the lernaeopodid *B. thynni* was collected from the longfin tuna or albacore *T. alalunga*. A number of copepods were collected from a single host, similar to the caligid *G. huttoni*. It has long egg sacs. A redescription would give some new insights on this species. In total, there are 11 species of six genera of Lernaeopodidae have been recorded in Korea (Table 2).

The Lernanthropidae is the third largest family among the siphonostomatoids following the Lernaeopodidae and Caligidae (Ho *et al*., 2011). It consists of about 150 species that are exclusively parasitic on gill filaments of marine teleosts (Ho *et al.*, 2011; Venmathi Maran *et al.*, 2014a). In Korea, only two species of two genera such as *Lernanthropsis mugili* (Shishido, 1898) and *Lernanthropus tylosuri* Richiardi, 1880 have so far been reported (Kim, 1998). Both sexes of the lernanthorpid *L. spyraenae* collected from the same host off Taiwan were redescribed earlier (Ho *et al.*, 2008). The authors pointed out that there was a minor difference between the specimens of Yamaguti & Yamasu (1959) and their specimens. The specimens of Japan are ornamented with denticles on both rami of leg 1 but not so in specimens from Taiwan (Ho *et al.*, 2008). The specimens described herein were also not ornamented as like Taiwanese specimens. The majority of lernanthropids are occurring in tropical waters of Taiwan, India, Japan and UK. In India Pillai (1985) described more than 40

lernanthropid species (see Venmathi Maran *et al.*, 2014a), but from Korea, just 3 species from 3 genera have been reported (Table 2).

A checklist of three families such as Caligidae, Lernaeopodidae and Lernanthropidae of Korea is provided. More detailed studies are needed on these specimens, and increase in the number of collections could enhance the knowledge about the biodiversity of parasitic copepods in Korean waters.

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